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(54) **METHOD AND SYSTEM FOR NON-LOCKING AND NON-SKIDDING BRAKING/TRACTION OF A VEHICLE WHEEL.**

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landing conditions are difficult, or possibly he may see that the accessible landing runway is shorter than desirable, and he may then order activation of the braking system in advance by pushing a button. Situations may also be comtemplated in which for example a "dead man's control" is triggered in a train or some other vehicle, and thereby both triggers the braking power generally as well as the optimum braking system in accordance with the present invention. Possibly other types of emergency situations may be detected and automatically trigger a braking procedure which includes utilization of the optimum braking system in accordance with the present invention.

Obviously it is possible to combine in one and the same vehicle both effective traction and effective braking by "double" utilization of the present invention. One and the same computer 6 is used, and the same set of force or torque measuring devices 4, 5 are used in the combination of a traction and a braking system. The computer 6 will, depending on the state of driving, which is detectable quite simply by sensing the direction of the road parallel force F, respectively activate control devices for motors in a traction phase and control devices for braking power in a braking phase. For example all-terrain vehicles may benefit greatly from such a combination variant of the present invention.

In certain cases the braking executing organs and the controllable motor organs may be constituted by one and the same system, e.g. by using electromotors/generators, which during traction/ordinary driving operate as motors, but during braking conveys energy back to the energy reservoir or the vehicle (electrochemical batteries or other types of reservoir, for instance of the flywheel type) by operating as generators. Such cases may be particularly well adapted for combination with the above mentioned combined traction/braking control system in accordance with the present invention.

Once again it must be underlined that the present control principle for achieving effective traction or braking, in contrast to most previously known systems, are based upon the measurement of forces, and not upon measuring the rotation speed of the wheel. The wheel rpm is not necessary in order that the present invention shall function in a satisfactory manner. Nevertheless, in some cases it may be favourable to include the further information that may be achieved by sensing the wheel rotation speed, so that a further combination effect is achieved.

The ordinary "ABS" brakes used to-day, have the following unfortunate properties:

a) The ABS system is dependent on a certain minimum speed to function properly, because the wheel rotation speed is sensed directly.

b) The ABS system is partly dependent on measurements being undertaken on one or several other wheels in order to function properly.

c) Blocking of brakes are prevented, but the braking distance may be extended.

d) As a consequence of item a) above, the ABS system is unreliable at low speeds.

e) An ABS system renders no possibility for displaying the current friction conditions to a vehicle driver, for example an airplane pilot.

f) The ABS systems function at their best at high values of the friction coefficient. Because the optimum slip is totally different under slippery driving conditions, the ABS systems are not optimum under such conditions.

For the present invention the corresponding items hold valid:

a) It is not necessary to measure the wheel rotation speed.

b) If it is desired, each wheel may operate and be measured independently.

c) The braking distance is reduced essentially in all existing road and weather conditions, and at all existing speeds.

d) The system in accordance with the present invention is exactly as reliable at low speeds as at high speeds.

e) It is possible to present values of e.g. the friction coefficient in a display with the vehicle driver, in such a manner that information actually is given regarding the current braking conditions. In this respect a continuous electronic monitoring of the road conditions is actually undertaken by means of the present system.

f) It is actually a fact that when using a braking system in accordance with the present invention, the electronic circuitry functions at its best in the case of typically "flat" friction coefficient curves (see Fig. 1, curve 7) which is typically found in connection with a slippery road surface. In other words, the present system functions well exactly in those situations where achieving optimum braking is important.

Claims

1. A method for achieving optimum braking of a vehicle wheel (1), comprising measuring/recording braking condition related physical parameters for said wheel (1), as well as controlling the braking force or power with an electronic control unit (6) in accordance with running calculations based upon the parameter measurements,
characterized in that the road normal force and the road parallel force on the wheel axle (3) is recorded continuously by means of at

least one force measuring device (4, 5), that the wheel friction coefficient against the road or the ground (2) as well as the variation of said coefficient is determined runningly in the electronic control unit (6) from the recorded force values, and that the braking force or power is altered in a running manner on the basis of the values of said friction coefficient and the variation thereof, in such a direction that the instantaneous maximum friction coefficient is reached.

2. A method in accordance with claim 1, **characterized** in that said braking force or power is only influenced by the electronic control unit (6) if an optimum braking effect is desirable or necessary, e.g. by recording the manual or pedal influence procedure of a vehicle driver and immediately comparing said procedure to pre-stored threshold values of influencing deflection or velocity, possibly semi-automatically in that the driver orders optimum braking effect in advance, or automatically by triggering "a dead man's control" or by an emergency situation triggering an automatic braking procedure.

3. Braking system for wheeled vehicles including trains and airplanes, comprising driver's or operator's operating devices, order- or force-transmitting means, possibly including force amplifying means (8), an electronic control unit (6) and braking exercising means (9) attached to the wheels, **characterized** in that said system comprises at least one force measuring device (4, 5) attached to at least one of the vehicle wheel axles (3) for measuring road normal force and road parallel force on said axle (3) and with a signal connection to the electronic control unit (6), and that said electronic control unit (6) is adapted to control the braking forces or power in accordance with the results of running calculations of the friction coefficient between wheel (1) and road or ground (2), as well as the variation of said coefficient, on the basis on the continuously incoming measuring signals from said force measuring device(s) (4, 5), in such a direction that the instantaneous maximum friction coefficient is reached.

4. A method for achieving optimum traction for a vehicle wheel (1), comprising measuring/recording traction condition related physical parameters for said wheel (1), and controlling the traction force or power with an electronic control unit (6) in accordance with running calculations on the basis of the parameter measurements, **characterized** in that the road normal force and the road parallel force on the wheel axle is recorded continuously by means of at least one force measuring device (4, 5), that the wheel friction coefficient against the road or ground as well as the variation of said coefficient is determined in a running manner in said electronic control unit (6) from the recorded force values, and that the traction force or power is altered runningly on the basis of the values of said friction coefficient and the variation thereof, in such a direction that the instantaneous maximum friction coefficient is reached.

5. A method in accordance with claim 4, **characterized** in that the traction force or power is only influenced by the electronic control unit (6) if optimum traction effect is desirable or necessary, e.g. by recording the manual or pedal influence procedure of a vehicle driver, and immediately comparing said procedure with pre-stored threshold values of influence deflection or velocity, possibly semi-automatically by letting the driver order optimum traction effect in advance.

6. Traction system for wheeled vehicles including trains, comprising driver's or operator's operating devices, order-transmitting means, an electronic control unit (6) and controllable motor organs (10), **characterized** in that said system comprises at least one force measuring device (4, 5) attached to at least one of the vehicle wheel axles for measuring road normal force and road parallel force on said axle and with signal connection to the electronic control unit (6), and that said electronic control unit (6) is adapted for controlling the traction forces or power in accordance with the results of running calculations of the friction coefficient between wheel and road or ground, as well as the variation of said coefficient, on the basis of the continuously incoming measurement signals from said force measuring device(s) (4, 5), in such a direction that the instantaneous maximum friction coefficient is reached.

7. A method for achieving both optimum traction for and optimum braking of a vehicle wheel (1), including measuring/recording traction condition related, respectively braking condition related physical parameters of the wheel (1), and controlling the traction force or power, respectively the braking force or power with an electronic control unit (6) in accordance with

running calculations on the basis of the parameter measurements,
characterized in that the road normal force and the road parallel force on the wheel axle is recorded continuously by means of at least one force measuring device (4, 5), that the wheel friction coefficient against the road or the ground (2), as well as the variation of said coefficient, is determined in a running manner in the electronic control unit (6) from the recorded force values, and that the traction force or power, respectively the braking force or power is altered runningly on the basis of the values of the friction coefficient and the variation thereof, in such a direction that the instantaneous maximum friction coefficient is reached, said electronic control unit (6) selecting influence upon braking force or traction force from the measured direction or sign of the road parallel force.

8. A braking/traction system for a wheeled vehicle, comprising driver's or operator's operating devices, order- and force-transmitting means, possibly including force amplifying means (8), an electronic control unit (6), controllable motor organs (10) as well as braking exercising means (9) attached to the wheels (1),
characterized in that said system comprises at least one force measuring device (4, 5) attached to at least one of the vehicle wheel axles (3) for measuring road normal force and road parallel force on said axle (3) and with signal connection to the electronic control unit (6), and that said electronic control unit (6) is adapted for controlling the braking, respectively the traction power or forces in accordance with the results of running calculations of the friction coefficient between wheel (1) and road or ground (2), as well as the variation of said coefficient, on the basis of the continuously incoming measurement signals from the force measuring device(s) (4, 5), in such a direction that the instantaneous maximum friction coefficient is reached, and furthermore is adapted for selecting traction or braking depending on the direction or the sign of the measured road parallel force.

9. Braking/traction system in accordance with claim 8,
characterized in that one and the same tilt-action force measuring device is adapted for measuring both the road normal and the road parallel force simultaneously in the form of their resultant, the electronic control unit (6) decomposing said resultant calculation-wise in accordance with the angular relations of said force measuring device to the road or the ground, said angular relations being either constant, known or runningly measurable by means of a separate angular sensor delivering an angular measurement signal to the electronic control unit (6).

10. Braking/traction system in accordance with claim 8,
characterized in that separate force measuring devices (4, 5) are arranged for measuring respectively road parallel and road normal forces, said separate force measuring devices (4, 5) possibly being adapted to operate directly in the road parallel and road normal directions, or individually tilted in relation to said directions.

Patentansprüche

1. Eine Methode für die Erzielung der optimalen Abbremsung eines Fahrzeugrads (1), bestehend aus der Messung/Aufzeichnung der für die Bremsbedingungen relevanten physikalischen Parameter dieses Rads (1), sowie der Steuerung der Bremskraft oder -leistung mit einer elektronischen Steuereinheit (6) gemäß den laufenden Berechnungen aus den Parametermessungen,
gekennzeichnet durch daß die auf die Radachse (3) wirkende Straßennormalkraft und Straßenparallelkraft ständig mit mindestens einem Kraftmesser (4, 5) gemessen wird, und daß der Reibungskoeffizient mit der Straße oder dem Boden (2) sowie die Schwankung dieses Koeffizienten ständig in der elektronischen Steuereinheit (6) aus den aufgezeichneten Kraftwerten ermittelt wird, und daß die Bremskraft oder -leistung laufend gemäß den Werten dieses Reibungskoeffizienten und gemäß seinen Schwankungen geändert wird, so daß der momentan höchste Reibungskoeffizient erzielt wird.

2. Eine Methode gemäß Patentanspruch 1,
gekennzeichnet dadurch, daß diese Bremskraft oder -leistung nur dann von der elektronischen Steuereinheit (6) beeinflußt wird, wenn es wünschenswert oder nötig ist, eine optimale Bremswirkung zu erzielen, z.B. durch die Aufzeichnung der manuellen oder Pedalsteuerung durch einen Fahrzeugführer und sofortiges Vergleichen dieser Steuerung mit vorgespeicherten Grenzwerten zu Auslenkungsgrad oder -geschwindigkeit, möglicherweise halbautomatisch, so daß der Fahrer optimales Bremsen voreinstellen kann, oder automatisch, indem